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Abstract

This article analyzes the contractual relationship between a wine cooperative (winery) and its member (growers). This relationship is plagued by moral hazard and adverse selection problems in grape quality. Indeed, growers can be opportunistic since the cooperative is unable to observe: (i) their effort level due to imperfect monitoring technology; (ii) their productive abilities (types) due to adverse selection. Because the growers' vineyard practices and efforts are one of the main determinants of grape quality, the cooperative implements an incentive compensation system to induce growers to provide the maximum effort towards quality. This compensation scheme is similar to that in tournaments (Lazear and Rosen, 1981; Green and Stokey, 1983; Knoeber, 1989; Prendergast, 1999). In our case, the cooperative promotes competition between growers by offering a promotion, while, at the same time, organizing the contest by creating homogenous groups of growers using a menu of contracts and monitoring through regular visits to the vineyard. Using a database of 1219 contracts, we test the effect of: (*i*) the cooperative's tournament compensation scheme; (*ii*) the menu of contracts and monitoring mechanism. The results of our econometric estimations provide some confirmation of both effects. (JEL classification: L14, D82, Q13)

Keywords

Wine grape supply contracts, quality, tournament, cooperative.

This article has been accepted for publication and will appear in a revised form in the Journal of Wine Economics, vol. 9, no. 3, p. 320-345, *published by Cambridge University Press.*

1 Introduction

Growers' vineyard practices are one of the main determinants of grape quality[1]. But wineries face a classical agency relationship with its growers. That is, the cooperative's (winery) interest is for growers to deliver quality grapes. However, two problems arise: first, wineries are unable to observe the grower's effort level (moral hazard). Their remuneration is based only on proxies, i.e. observable indicators, of the grape quality once delivered to the winery. Second, the growers have different ability and productivity (adverse selection).

In this paper, we study a wine cooperative in the South West of France that implements an incentive compensation system to induce growers to provide the maximum effort towards quality. To do so, it sets a differentiated payment system and a system of promotions. Compensation is not based on the absolute quality of their grape, but instead on a relative performance scheme, where the individual output is compared to that of their peers. This compensation scheme is similar to that in tournaments (Lazear and Rosen, 1981; Green and Stokey, 1983; Knoeber, 1989). In our case, the cooperative promotes competition between growers, first by promising the possibility for a grower to be "promoted" to a higher quality contract, and second by providing a price differential within each quality contract, an additional incentive for growers to search for higher prices. At the same time, the cooperative needs to face the adverse selection problem by organizing the competition between different homogenous groups. For this, the cooperative proposes a menu of contracts and monitors the production process.

Our empirical results from a database of 1219 contracts confirm that the tournament mechanism aims to: (i) provide some incentives in presence of a common shock that may affect all the growers; (ii) reduce the heterogeneity among the growers embedded in the same contest depending on the contract chosen.

This paper is organized as follows. Section 2 provides a short overview of the theoretical approaches when agency problems are at stake in the production of quality grapes and tournament theory. Section 3 describes the wine cooperative's contract stages and the organization of our database. Results are presented in Section 4. The last section brings some concluding remarks.

[1] In this article we focus on grape quality. Wine quality is going to be determined by the quality of grapes but also the technological choices involved in the wine-production process (Gergaud and Ginsburgh, 2008)

2 Quality incentives and contracts

While explicit contracts in the wine grape production have been largely used between independent growers and wineries (Gaucher et al., 2002; Goodhue et al., 2003; Fraser, 2005; Fares, 2009), in this paper we focus on cooperative organizations where the growers are both suppliers of the grapes and members of the cooperative. The cooperative faces a classical agency relationship with its growers (Alchian and Demsetz, 1972; Jensen and Meckling, 1976; Pennerstorfer and Weiss, 2013). In the case of cooperative-grower, or principal-agent, “one party [grower] has an informational advantage over another [cooperative] that can be exploited to the benefit of the advantaged party” (Jensen and Meckling, 1976). The first kind of asymmetric information is the adverse selection problem, where the grower is supposed to know his characteristics, skills and competencies (his type) but the cooperative cannot observe them without cost. To overcome the problem of adverse selection, the cooperative offers a “menu of contracts”. If the menu is well-designed, the grower may reveal his type by choosing the contract that maximizes his utility. The second kind of problem is the moral hazard problem, where the cooperative cannot observe the effort in grape quality undertaken by the grower once the contract is signed. Therefore, the contract offered by the cooperative has also to give incentives to effort. An optimal compensation scheme based on the observable output is defined. When the grower has some risk aversion, this optimal compensation scheme is confronted with the “incentive versus insurance” trade-off (Sappington, 1991). In this case, a piece rate mechanism (with a fixed base pay) can be optimal.

In practice, the vineyard contract relationship departs from this simple model since the output (quality) itself is costly to monitor (Gaucher et al., 2002). First, there are no easy ways to control (thus, enforce) the grower’s vineyard practices. Even if the cooperative’s technicians visit the vineyard during the year and provide extension services, the actual work in the vineyard is not observed. Second, there is no easy *ex post* evaluation of the output (grape quality), although there are tests based on pre-established parameters, such as sugar contents (Alston et al., 2011), or the sanitary and physiochemical proprieties of grapes that could indeed provide some indication (Montaigne et al., 2007). However, they do not directly reflect the grower’s effort level. Finally, there is no “mechanical” relationship between the application of specific vineyard practices and the qualitative end result of grapes. Elements related to the pedoclimatic environment of land blocks or yearly meteorological conditions could influence the output attributes (Ashenfelter, 2008; Ashenfelter and Storchmann, 2010).

In cases where monitoring is either unreliable or costly, tournaments could be a desirable incentive scheme (Lazear and Rosen, 1981). This compensation system remunerates individual performance not on the absolute value of their output, but on the position their output ranks compared to that of their peers. In what follows, we characterize the efficient solution of a compensation scheme piece rate (2.1), before analyzing the specificities of a differentiated compensation scheme, where agents can be heterogeneous (2.2).

2.1 Agency problems and piece rate compensation scheme

The timing of the relationship between the cooperative and the grower is defined as follows. In the first period, the cooperative offers a menu of contracts and the grower chooses the contract that maximizes his expected utility. In the second period, given the contract chosen, the grower i undertakes an investment or effort level e_i that increases his performance, i.e. the quality q_i of the grape produced (output). Developing investment or exerting effort is costly to the grower and $C(e_i) = \theta_i e_i^2/2$ denotes the cost of investment or effort, with θ_i the grower ability or productive parameter. Quality may also be impacted by a common shock (η) and an idiosyncratic shock (ε_i). The shocks follow an i.i.d. normal distribution with mean zero, and the common shock has a variance σ_η^2 while the idiosyncratic shock has a variance σ_ε^2. The quality production function can be written as follows

$$q_i = e_i + \eta + \varepsilon_i \qquad [1]$$

The cooperative cannot observe the grower's effort and thus cannot assert the extent to which the quality produced (or some of its proxies) is due to effort or to shocks, either common or idiosyncratic.

In the case where a piece rate contract can be used to remunerate growers (Lazear and Rosen, 1981; Gibbons, 1987), the growers are paid based on output (quality). Because output q_i is dependent on effort e_i, a piece rate contract should encourage greater effort and penalties could be applied if the observed output is insufficient. Following Lazear and Rosen (1981), we suppose for ease of exposition that growers are risk neutral and free entry in a competitive output market set the value of the product at V per unit. Let r_i be the piece rate, then the grower net income $r_i q_i - C(e_i)$. A risk-neutral grower chooses e_i to maximize his utility

$$E[r_i q_i - C(e_i)] = [r_i(e_i) - C(e_i)] \quad [2]$$

The first order condition of this program is $r_i = e_i/\theta_i$, i.e. the piece rate equates the marginal cost of effort. Since the cooperative is also supposed to be risk neutral, its expected profit is $E[Vq_i - r_i q_i] = (V - r_i)e_i$. Because the free entry assumption implies $r_i = V$, substituting in [2] and deriving gives

$$C'(e_i) = V \quad [3]$$

That is, the marginal cost of effort equals its social return. The optimal effort level is then $e_i^* = \theta_i V$. This result suggests that piece rate is an efficient compensation scheme. However, since it is costly and difficult for the cooperative to directly measure the grower absolute level of each grower's output[2], it can be more efficient to observe the relative position of each grower by ranking the different output levels (Prendergast, 1999).

2.2 Tournaments and relative compensation schemes

The wine cooperative's differentiated payment system studied in this paper is like a tournament. Tournaments remunerate individual performance, not on their absolute value, but on the position of their output ranking compared to that of their peers. The literature on tournament (Lazear and Rosen, 1981; Green and Stokey, 1983; Knoeber, 1989) shows the cases where the principal promotes competition between agents because monitoring of output itself is either unreliable or costly. In our case, the cooperative creates incentives to work harder first by promising the possibility for a grower to be "promoted" to a higher quality contract and, second, by providing a price differential within each quality contract that provides an additional incentive for growers to work harder for a better quality.

Promotions are used to sort workers based on their talents and reward them accordingly (Rosen, 1982). In a tournament system, the winning prize is a promotion, which should be an incentive for the agents to improve their effort level (Prendergast, 1999). Lazear and Rosen (1981) were the first to study this type of payment system. In the presence of high monitoring costs, with regards to effort and final output, this type of payment system is preferred because it

[2] As mentioned above, sanitary and physico-chemical proprieties are not completely objective measurements of quality.

would be less expensive to observe the relative position of agents with regard to each other than to measure their individual production levels. Green and Stokey (1983) and Nalebuff and Stiglitz (1983) deepened the analysis by considering that tournaments are particularly preferred when the agents are confronted with a common shock (random variable that might represent economic conditions that affect all of the agents). As stated in Tsoulouhas and Marinakis (2007) and Tsoulouhas (2010), when agent production activities are subject to common shock individual performance is not a sufficient statistic for individual effort. The performance levels obtained by the rest of the agents convey an informative signal about the common shock and, thus the effort choice of any given agent. Therefore, tournaments constitute a move closer to the first best solution because the principal uses the available information more efficiently. By removing common uncertainty from the responsibility of agents, and by charging a premium for this insurance, the principal increases his profit without hurting the agents.

To give an intuition of the main result of the tournament mechanism, we follow the Lazear and Rosen (1981) simple model where the two agents (growers) are rewarded for their performance with one of two prizes, $t_1 \; or \; t_2$, where $t_1 > t_2$. The higher prize t_1 goes to the grower with the better performance, while the lower prize goes to the poorer performing grower. The probability of a grower *i* wining the higher prize depends positively upon his own effort (e_i). Let *P* be the probability of winning the tournament[3], the expected payoff to grower *i* is

$$P(e_i)\left[t_1 - C(e_i)\right] + \left(1 - P(e_i)\right)\left[t_2 - C(e_i)\right] = P(e_i)(t_1 - t_2) + t_2 - C(e_i) \qquad [4]$$

Assuming risk neutrality and holding the opponent's action constant, grower *i* will choose e_i to maximize [4]. By deriving the grower payoff with respect to e_i, the first order condition is $P'(e_i)(t_1 - t_2) = C'(e_i)$. In a symmetric Nash equilibrium, where grower *j* reasons similarly to grower *i*, the effort level implemented is

$$e = (t_1 - t_2)\left[\frac{P\prime}{\theta}\right] \qquad [5]$$

This implies that effort depends positively upon: (i) the marginal effect of effort on the probability of winning (P'); and (ii) the prize differential $(t_1 - t_2)$. This latter implies that effort is unaffected by changes in the absolute level of prizes that leave this differential constant[4]. This price differential mechanism of the tournament provides protection to growers against common shocks. Indeed, if these shocks are systematically applied, universally boosting or decreasing production signals do not change the rankings between growers, and thus their expected payoff.

[3] Which could be the probability of a promotion as in Heutel (2009).
[4] As shown in Prendergast (1999), effort should also increase in the efficiency of monitoring.

This tournament mechanism can achieve the efficient solution ($e = e^*$) by choosing a prize differential such that

$$(t_1 - t_2) = [\frac{V}{p'}] \qquad [6]$$

This result shows that tournament mechanism can also achieve an efficient outcome when the growers are risk-neutral. When they are risk averse, this efficiency result cannot be obtained with piece rates and tournaments due to the trade-off between incentives and insurance. When there are no common shocks and only idiosyncratic shocks, the piece rates do provide an improvement over tournaments. In contrast, relative pay in tournaments may yield greater effort than pieces rates when a common shock is sufficiently large (Tsoulouhas and Marinakis, 2007).

The empirical papers on tournaments that studied the North American broiler production industry, confirm the theoretical predictions (Knoeber, 1989; Knoeber and Thurman, 1994). They find that: (i) the extent of this payment depends on the grower's relative performance with regard to others (measured by the grower's settlement cost compared to an average); (ii) changes in the level of prizes that do not change the prize differentials motivate no change in chicken production (and thus, farmer effort). Ehrenberg and Bognanno (1990) provide also interesting empirical confirmation of tournament's effect on the effort of competitors through their analysis of professional golfers. Main et al. (1993) show that promotion from corporate vice-president to president generates a pay increase, which is positively correlated to the number of vice-presidents competing for the position. That is, the executive pay is the prize of a tournament rather than compensation for value added. Eriksson (1999) presents similar findings by regressing firm performance (log (profit/sales)) by pay differentials (the gap between CEO and VP pay), controlling for industry and firm-size. His pay differential yields a statistically significant coefficient, which gives some evidence of the main prediction of the theory.

2.3 Organizing the contest between heterogeneous growers

In the previous simple models the growers were supposed homogenous. In practice, growers may be heterogeneous and thus each one will respond differently in the tournament to the prize differential and/or promotion. That is, growers with high cost of effort may choose zero effort because of their competitive disadvantage; or they can take excessive risks in hope of leaping ahead of the frontrunner. Therefore, when agents are heterogeneous relative performance evaluation via tournaments exposes agents to uncertainty about the average agent ability. The rationale is that, unlike piece rates, tournaments filter away common uncertainty from the responsibility of agents who pay a premium for this insurance. Since tournaments expose agents to the idiosyncratic shocks of other agents, so that tournaments become less desirable when the variance of the distribution of ability types (heterogeneity) is large (Tsoulouhas and Vukina, 2001; Tsoulouhas and Marinakis, 2007).

This problem of adverse selection in tournaments has been documented first by Lazear and Rosen (1981) who show that without a specific mechanism, agents would not self-select since it is more interesting for all agents to be in the high ability group. Consider the simple case of two different types of growers, who know their type (ability) but the cooperative does not. There are two leagues: league θ_H wich yields the most efficient outcome given the high ability people and league θ_L, which yields the highest outcome given low ability growers. The problem is that league θ_H is strictly prefered since it generates a strictly higher payoff. This leads to the lower type θ_L contaminating league θ_H which results in a mixed "league" bag of growers of different abilities. That is, growers have no incentive to sort themselves in the two leagues according to their abilities. As shown above, this "league composition risk" (Tsoulouhas and Vukina, 2001) may lead to inefficiency since growers will provide less effort and or take more risks. Bull et al. (1987) found that there is a large variance in tournament settings in the effort levels, and despite introducing more information such as the opponent's effort levels, there is still much variance. Starting from this early experimental tournament paper, several lab experimental studies examine the relationship between effort provision and heterogeneity. For example, Tsoulouhas et al. (2007), Gurtler and Harbring (2010) and Vandegrift and Yavas (2010) find support for the prediction that equilibrium effort is lower in asymmetric tournaments because reduced effort does not change player's relative position. However, Eriksson et al. (2009) show that previous experimental evidence regarding the variability of effort in tournaments is misleading because the experiments have not accounted for sorting. That is, agents typically choose to participate in a tournament. So, they used a similar setup to that of Bull et al. (1987), except that the participants had a choice when they participate: they can choose between piece rates and relative pay. They find that those who choose the tournament provide, on average, higher effort. After running the experiments, they also did a questionnaire with several lottery decisions to elicit the risk aversion of each participant. They found that risk adverse agents tend to choose the piece rate scheme. This sorting leads to two homogeneous groups, which reduces the between subject variance dramatically in the tournaments.

Another solution to sort between heterogeneous agents is to offer a menu of contracts.

Following Bhattacharya and Guasch (1988), Riis (2010) shows that when agents are heterogeneous *ex ante* and the optimal discriminatory prize premium is non-monotonic in ability, efficiency can be restored if agents choose from a menu. Wang and Jaenicke (2005) show that a menu of two contracts may also simultaneously shift surplus from low to high ability growers. Further, a "cream-skimming" contract that pools only growers above a certain ability level may, under certain circumstances, increase the expected utility of participating growers and reduce the expected profit of the Principal (processor). In contrast, Tsoulouhas (2013) shows that no menu of contract is needed *ex ante* since the *ex post* tournament mechanism can sort between growers if they are known to be not very heterogeneous.

In our case, the wine making cooperative tries to screen the growers by their ability and organize contest in subgroups where growers can be the less heterogeneous possible. This is done in two steps. First, *ex ante* growers are screened and reveal their type by choosing the contract that maximizes their expected utility in the menu of contracts offered by the cooperative. Second, before harvest and contest, the cooperative may downgrade growers and their land blocks that are unable to achieve a minimum quality inside their group. This help to reduce the variance of the outcome inside group once the harvest is done. Once this problem of heterogeneity is solved, the tournament mechanism is probably the best alternative when common shock is sufficiently large. Indeed, it eliminates the variations of revenues caused by factors common to all growers, either variations of measurement or variations related to the environment. This is particularly true in the case of cooperatives, which are delimited to a geographical area making it more likely for growers to be affected by climatic hazards. Tournaments should also reduce the cost related to measuring performance and maintain incentives for maximum effort, while removing common shocks to all participants[5].

3 Data and methods: the case of the Saint Mont vineyard

The Saint Mont vineyard[6], as well as the studied cooperative[7], has experienced a transformation process similar to that of other cooperatives in the French "South West," going from a mass wine

[5] In contrast to what is usually analyzed in the literature, we observe that the cooperative adopts cardinal, two-part piece rate tournaments, rather than on rank order tournaments. The rationale is that tournaments based on rank, with prespecified prizes, are informationally wasteful if performance levels can be measured cardinally rather than ordinally (Holmström, 1982).

[6] The Saint Mont vineyard is located in the far west of the Gers department, in the Midi Pyrénées Region. The Saint Mont designation, which was *Appellation d'origine Vins délimitées de qualité supérieur* (Designation of Origin Delimited Wine of Superior Quality. AOVDQS, for its acronym in French) and recently upgraded to Appellation d'Origine Protegée (Protected Designation of Origin, PDO. AOP, for its acronym in French), comprises an extension of 1,112 hectares and 194 wine growers (INAO, 2010).

production to a more quality-focused production. This shift has translated into a payment system that guides producers towards medium and long-term planning and strongly encourages them to make effort in quality of grapes (Chiffoleau et al., 2007). In this section, we present the different steps of the contractual process from the moment a grower chooses a contract to the arrival of grapes to the cooperative after harvest. This information is registered in the cooperative's traceability database, which allows for a better management, and monitoring, of the grape production. We test in this database (*i*) the efficiency of the cooperative's tournament compensation system, i.e. if a promotion have a positive effect on effort and thus on final qualitative output; (*ii*) the effect of the monitoring mechanism and menu of contracts on the efficient contest organization. .

3.1 The timing of contracts

The contractual process begins in April of each year (see figure 1), when growers commit one or more land blocks to a quality contract until September, when the grape harvest takes place.[8]

In step 1, the cooperative offers a menu of contracts $<A,B,C>$. The quality requirements and the cost of each contract is such that the grower's profit represented by $\Pi^A \geq \Pi^B \geq \Pi^C$. These contracts, to which the grower has committed one or more land blocks, have certain requirements that must be followed. At this step, the cooperative takes some preventive measures to screen among heterogeneous growers and land blocks. For example, to commit a land plot to contract A, the land blocks should belong to a property [9] or they must have been committed to an A contract for the previous three years.

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[7] The studied cooperative, *Plaimont Producteurs*, is a group which resulted from the "merge" of *Plaisaince*, *Aignan* and *Saint-Mont* cooperatives in the Gers Department. *Plaimont Producteurs* is composed of approximately 1,000 producers who work in 5,300 hectares of vineyards. It produces 36 million of bottles, which are sold worldwide every year, and generates annual revenues of 64 million Euros (27 million correspond to exports) and employs 150 people.

[8] After conducting interviews with the cooperative's technicians, site visits and reviewing documents provided by the cooperative, we were able to analytically reconstruct the contractual process.

[9] In French called *château* or *domaine*

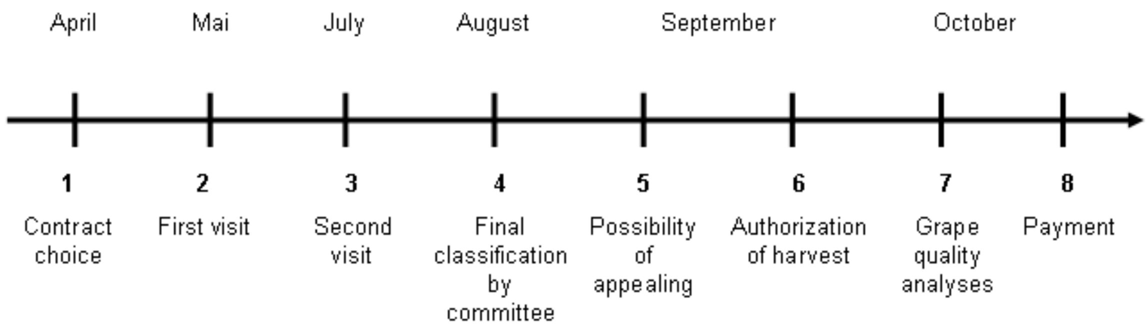

Figure 1: *Steps of the wine-grape production contract.*

Steps 2 and 3 consist of visits from technicians to evaluate, validate and guide the work of the grower. These visits are part of the "monitoring" process, which aims to avoid moral hazards, or hidden actions such as non-compliance with the contract.[10] In doing so, the cooperative can screen again between growers. Indeed, by monitoring the cooperative aims to ensure homogenous groups before harvest and contest.

If everything occurs according to the plan, the grower that made all of the necessary efforts and complied with the contract should produce a better quality grape than the one that did not. However, land plot characteristics (e.g., location, pedoclimatic conditions) may not be aligned with the desired quality. Consequently, if a plot committed to certain contract did not correspond to its potential – in our example, land that is not suitable for an A contract – all efforts made by the grower would end up being pointless because he could be penalized after the qualitative analyses. On the contrary, if the land has a greater potential, with only a little effort from the grower the analysis results could show a high-quality wine.[11]

Nonetheless, the risk, especially regarding land potential, would raise one problem regarding tournaments. If agents know – or believe they know – of the high potential of their land, they could make a little effort and with high-quality production, finish at the top of their tournaments. On the contrary, those who consider that they own "low-potential land" will make little effort to remedy their situation because they will conclude that their land is going to be downgraded anyway.

[10] This, of course, will not rule out opportunistic behavior, such as making a maximum effort to show compliance before visits, but it should provide a good indication of the cooperative's control, monitoring and enforcement of contracts.

[11] The issue with land potential could partially come from adverse selection, but in reality this "potential" is not actually known neither by the cooperative or the grower.

In step 4, a committee composed of growers and technicians proceeds to classify – and eventually downgrade – the various land blocks (see figure 2). This classification helps the cooperative to determine the quality of grape that will arrive to their facilities after harvest and foresee the type of remuneration that the grower will receive. For example, a land block engaged in an A contract (at this step) is downgraded to B or C because the requirements of the contract were not met.[12]

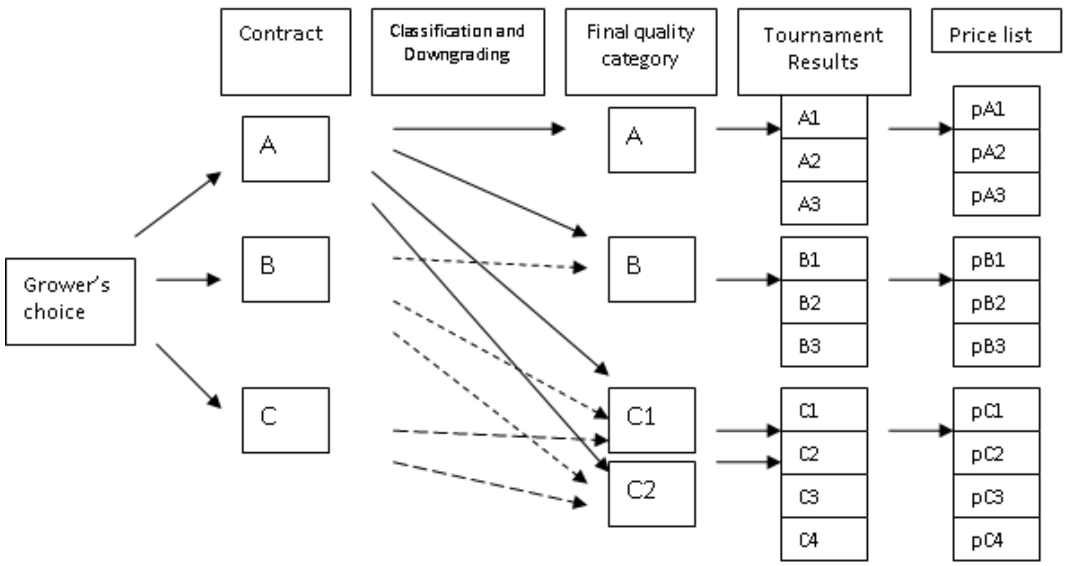

Figure 2: *Classifying and downgrading wine-grape land blocks.*

This constitutes a crucial moment because the fulfillment of the contract is verified. For instance, if the grower engages a plot of land to an A contract, he/she expects to be paid according to the A price scale (pA1 to pA3, see figure 2) depending on the results of the contribution analysis. However, if they agreed to an A contract, but find themselves with several land block downgraded to C1 or C2, this will heavily penalize their compensation because they will only have the right to opt for prices pC1 to pC3.

There is an additional feature in the payment system (a contractual provision). The compensation to each land block is a function of the price and the yield of all land plots within the

[12] The difference between the C1 and C2 classification in figure 2 corresponds to quality C grapes for producing red wines (C1) and rosé (C2).

contract, but there are ceiling levels in terms of yield (as a measure of quality).[13] In the case of a contract A (tournament A), a grower's compensation (prices pA1 to pA3) will only be paid up to a yield of 45 hectoliters/ha. After breaching that ceiling, yield will be paid at a price p_c (complement price), which is close to 1/5 of pA1[14].

The penalty for surpassing the fixed yield ceiling, and incurring in a loss, is another incentive for additional effort. The contract, especially for high-quality contracts (A and B), stipulates a mode of cultivation that needs strong management of the expected yield. For instance, the process of disbudding and pruning the vine is very costly in terms of working hours and differs from one contract to another.[15] This means that a grower engaged in contract A will not only play in a tournament A, but he/she must also be careful of their yield and should provide the maximum effort to manage the yield within the respective ceilings. In any case, growers can appeal the step 4 decision (step 5).

In step 6, samples are taken, and three ripeness tests are carried, in order for the cooperative's technicians to allow the harvest of grapes. This evidences the authority mechanism the cooperative applies, which could differ from the grower's interests, who for instance, could prefer to harvest in another moment. In step 7, samples of each contribution are analyzed and a corresponding score is calculated in accordance with its group average quality. In step 8 the remuneration is made according to the final classification (result of the tournament) and to the ceiling criteria in terms of the yield set in the price scale.

3.2 The database

The main database, referred to as "Geowine StMont" database, contains two types of information from different sources. The first type comes from the wine cooperative's traceability database.[16] It contains information on each grower's individual contribution of grapes since the year 2000. It provides detailed information on each grape contribution (e.g., yield, grape variety), characteristics of each land block, the type of contract engaged, the land block's classification (at

[13] In viticulture lower yields are related to higher quality.

[14] Up to 66 hectoliters/ha, which is the maximum yield allowed by the AOP's regulation. After this ceiling it is all losses.

[15] The cooperative estimates that there are approximately 1600 euros/ha in between contracts A, B and C.

[16] Traceability systems make information available on products' attributes and transformations that can be used to improve safety and quality (Galliano and Orozco, 2011). Beyond the record-keeping information to respond to a public authority inquiry, the cooperative uses this information to improve their productive and management systems.

step 4) and the final compensation category. These data are further complemented by information provided by the cooperative, such as the price paid for each compensation category and individual information about growers, such as age, gender and total arable land surface. The second source comes from the work of researchers at the *École d'Ingénieurs de Purpan* (Gay, 2010). These are geographic variables such as soil, altitude, slope and orientation exposition.[17]

The test is carried on a sample of 1219 land blocks belonging to 120 growers. Summary statistics and definition of variables are presented in table 1.

3.2.1 Variables

The analysis was performed using data from the 2008 harvest. The main reason for this choice is that, after 2007, the different contracts became more differentiated in terms of quality requirements, but in 2007, many vines were damaged by environmental factors (hail storms). In addition, we only take into account the grape production for red wines because they have three contract types (instead of two for whites) and they represent almost 80% of all grape production in the Saint Mont AOP.

Our **dependent variable**, REMTOT, is the payment for each land plot provision of grape (in thousands of Euros for each hectoliter/hectare). This payment does not include the costs subtracted by the cooperative for the actual wine production but is an indication of the quality of grapes because the price paid to each land block depends upon the quality category it was assigned to after the downgrading process (step 4) and upon the price category after analysis (step 7). The type of contract initially chosen by the grower can be A (Contract A), B (Contract B) or C (Contract C). The requirements in quality are higher in contract A than contract B and higher than C. These dichotomous variables will be used for the selection equation.

The first group of **independent variables** concerns the prediction of the tournament model and the contractual provisions. The possibility of a promotion to a higher quality category should have a positive effect on the provision of quality effort. The probability of promotion increases with the number of promotions offered and decreases with the number of contestants (Heutel, 2009). We consider the dummy variable PROMO that equals one if the land block has been promoted from the previous year ($t-1$ to t). It could indicate that the grower wants to prove that

[17] This work was carried out by the researchers from the "École d'Ingénieurs de Purpan", as part of the WP1 of the Geowine project. These data concerned geological characteristics (mainly soil type) comes from the BRGM (*Bureau de Recherche Géologique et Minière*) of the Midi-Pyrénées region, while those concerning the topography (altitude, slope, and orientation) come from a numeric image of the region's landscape (Gay, 2010).

he/she deserved the promotion. Inversely, we consider a dummy variable DEMO that tests if the land plot has been demoted from category from the previous year.

Furthermore, we consider a variable to capture the monitoring activity of the cooperative. Tournament theory indicates that the higher the monitoring efficiency of the principal, the higher the effort from the agent should be (Prendergast, 1999). The variable DOWN indicates the land block has been downgraded at step 4 (figure 1) during the season (in year *t*). As previously mentioned, at this stage, a committee of growers and technicians (from the cooperative) evaluate the grower's work and determine if the contract has been followed. If this is the case, the plot of land remains in the same quality category; if not, the land block is downgraded to a lower quality category. In addition, this variable only takes into account the downgrading of a land block where the grower's effort did not meet the contract specifications (moral hazard). It does not take into consideration land blocks downgraded due to a climatic event or a disease to the vine.[18] The variable EFFCD indicates whether a land block suffered from a climatic or a disease event.

The variables YIELD and YIELD2 consider the average yield of each individual land block. The yield is measured in hectoliters/hectare and is relevant because, in viticulture, higher quality is associated with lower yields. The squared of yield, YIELD2 will allow us to observe if, after a certain ceiling, an additional unit of yield would have a negative effect on quality. The control of yields is probably the most important provision in quality contracts in viticulture. Concerning the grower, we take into consideration the grower's age (AGE), gender (GEND) and the number of year of experience in a type A contract (NYA). We also consider the percentage of vines over total arable land (VINEYARD), which signifies the degree of specialization of the grower in viticulture.

Finally, we consider variables related to the fixed characteristics of the land plot. The variable PROPERTY indicates that the land plot belongs to a chateau or a *domaine*. SURF refers to the land plot's total surface (in hectares). TANNAT indicates whether the variety of grape is Tannat or not.[19] The variable SOIL, which has five classes, that is, four types of soils representing 74.3% of all land blocks and one class, considered "out of the zone", representing the remaining land blocks. The four types of soil are mainly those with high presence of gravel, clay, molasse and iron-rich sand.

[18] In such cases, growers are compensated with a low price for their grapes by the cooperative, but they also receive a compensation from their insurance independently from the cooperative (not known in our study).
[19] Tannat is the main variety of the Saint Mont AOP. By regulation it must account at least for 60% of the final wine (INAO, 2010)

[Insert table 1]

4 The empirical model

In this section, we outline the empirical analysis. The two main objectives are, first, to test the efficiency of the cooperative's tournament compensation scheme system, in other words, to test that a promotion has a positive effect on effort (and thus on final qualitative output). Second, to test for the efficiency of the screening/selection mechanism to reduce heterogeneity among growers and blocks.

We estimate that the qualitative performance of land plots, thus grower's effort, is going to be dependent of their initial choice of contract. The choice of a specific contract (step 1 of the processes) by growers depends on the characteristics of the land block, the grower's experience and the performance of previous years. Thus, we test the existence of a selection bias since the effort level of growers is likely to depend on the type of contract there in. The choice made by the grower seems to be sequential, since he/she first chooses a contract to its land block, either A, B or C, and then he/she chooses his level of effort that in a certain extent defines the total compensation associated to the land block.

The first part is a binary outcome equation that models the probability of accepting a contract *i*, *i*=*A*, *B, C*. The probability of accepting a contract *i* can be described as follows

$$S_i^* = x_1^{'}\beta_1 + u_1 \tag{6}$$

where

$$S_i = \begin{cases} 1 \;\; if & S_i^* > 0 \\ 0 \;\; if & otherwise \end{cases}$$

The binary decision S_i to choose a contract *i* is modeled as the outcome of an unobserved latent variable S_i^*, and we observe that the contract is adopted ($S_i = 1$) when $S_i^* > 0$. It is assumed that S_i^* is a linear function of the exogenous covariates x_1 and a random component u_1.

The second part uses linear regression to model the total compensation obtained by the land block, given the decision on contract adoption. This can be expressed as

$$\pi = x_2^{'}\beta_2 + u_2 \tag{7}$$

where π is the total compensation for the land block, x_2 is a vector of exogenous explanatory variables and u_2 is a random component. Since the error terms u_1 and u_2 are supposed to be uncorrelated, then the two parts are assumed to be independent and are usually estimated separately. This can be however viewed as a restriction on the model. Indeed, if the land-blocks generating a positive compensation are not randomly selected from the population, after controlling for regressors, then the results of the second-stage regression suffer from selection bias.

In what follows we use the Heckman (1979) selection model, where the possibility of such selection bias is considered by allowing for possible dependence in the two parts of the model. That is, let the latent variable π^* denote the total compensation obtained by the land block, where the compensation is observed when π^*>0. In contrast to the hurdle model, π^* is observed only when $S_i^* > 0$. In such model, the errors u_1 and u_2 are possibly correlated and have a bivariate normal distribution with zero means and covariance matrix:

$$\begin{bmatrix} \sigma & \rho \\ \rho & 1 \end{bmatrix}$$

Since the error u_1 in (6) is believed to be correlated with the outcome variable, we need to correct for this bias by finding variables that are associated with holding a contract *i*, but are not associated with the outcomes of contract *j*.

The two-step method of estimation is based on the conditional expectation

$$\begin{aligned} E\left(\pi \middle| x, S_i^* > 0\right) &= x_2^{'}\beta_2 + E\left(u_2 \middle| S_i^* > 0\right) \\ &= x_2^{'}\beta_2 + \rho\lambda\left(x_1^{'}\beta_1\right) \end{aligned} \tag{8}$$

The method is as follows: (i) first estimate the probit equation by maximum likelihood to obtain estimates of β_1. For each observation in the selected sample, compute the inverse of the Mill's ratio or the non-selection hazards $\hat{\lambda} = \phi\left(x_1'\hat{\beta}_1\right)/\Phi\left(x_1'\beta_1\right)$ where ϕ and Φ are the standard normal density and distribution functions respectively; (ii) estimate β_2 and $\beta_\lambda = \rho\sigma$ by least squares regression of π on x and $\hat{\lambda}$. For more robust identification, we also impose exclusion restrictions, which requires that the selection equation have at least one exogenous variable excluded from the outcome equation. In our estimation, we use the variable PROPERTY since it has some effect on the selection and does not directly affect the compensation. With this exclusion restriction, we have $x_1 \neq x_2$ which may reduce the collinearity problem between the variable $\lambda\left(x_1'\hat{\beta}_1\right)$ with other regressors $\left(x_2\right)$ in the compensation equation. But since this problem in the two-step method of estimation generates higher standard errors than those of the maximum likelihood estimation procedure, we use also use this procedure.

5 Results and interpretation

Results from the second step of the Heckman model are presented in table 3. In addition, we present marginal effects of probit and OLS regressions for each contract in table 2.

In the probit results we obtain the factors explaining the choice of a contract (4.1). In the second step of the Heckman models, the factors explaining the qualitative performance of land blocks (4.2). The first group of variables in our regressions correspond to tournament mechanisms and contract provisions, then those related to the harvest, growers' characteristics and finally to land block characteristics.

5.1 The determinants of contract choice

The results from the probit model (table 2) show the factors associated with the choice of each one of the quality contracts. For contracts "A", model 1, our results show that four variables may explain this choice. First, the fact that the land block has been promoted from year $t-2$ and the number of years that the grower has been engaged in A contracts (NYA), but also the fact that the land block belongs to a property, and that the grape variety is TANNAT. The variable NYA reflects a reputation effect, or experience, but only related to such high quality contracts. Generic experience, usually captured with an age variable is not significant, at least for high quality contracts.

The fact that high quality contracts are associated with a property is not surprising. First, because it is a requirement in order to get into a high quality contract. Second, because it means that grapes from one property will only be mixed together in making the wine and bottled at the property. Finally, the use of TANNAT is also expected because is the main variety of the Saint Mont AOP and is the one preferred for the production for high quality wines.

For contract “B”, we found a negative and significant effect of age (between 21 and 35 years of age) and the number of years with an A contract. It seems that in this case young growers are less likely carry type B contracts, instead they will start with less demanding type C contracts. It also seems that more years of experience in A contracts, the more likely the grower will continue to choose A or B contracts. In addition, the wineries to which the growers belong play a significant role in the type of contract they choose. Belonging to “Cave de Saint Mont” winery, determines in part the choice of B contracts, while those belonging to “Aignan” and “Plaissance” winery are more likely to choose C contracts. With regards to the characteristics of land blocks, we found several factors explaining this choice: the size of the land block (SURF) and the grape variety (TANNAT).

[Insert table 2]

We found opposite results for the selection of “C” contracts, a negative effect of promotion, age (young growers), NYA (number of years in A contracts), grape variety (TANNAT) and PROPERTY. It seems that the cooperative takes some measures, defined in the specifications chart, to screen growers in their contract choices.

5.2 The efficiency of the wine grape tournament

In this section we discuss the factors explaining the qualitative output of grapes, measured by the dependent variable REMTOT, that is, the compensation paid to a grower for an individual land block. In table 2 we show the results for OLS regressions for all types of contracts. However, we make the assumption that the qualitative performance of land blocks, thus grower's effort, is going to be dependent of their initial choice of contract. Therefore, we will discuss here the results of the second step of the heckman models, in which we account for this selection bias (table 3).

Using STATA's two-step method for Heckman models, we automatically obtain the inverse Mills's ratio. Using the maximum likelihood method, we obtain a test of chi2 that verifies that *rho* is significantly different from zero Rejecting the null hypothesis means that both equations are not independent from each other. The results of the maximum likelihood, as well as the two-step, Heckman's model show, first of all, that the correlation between the two equations is significant only for the choice of C contracts. It is not the case, however, for contracts A and B.

The compensation system is organize so that a grower's performance could be taken into account by the cooperative in order to "promote" the land block to a higher quality category, or to "demote" it to a lower category. In models 8 and 11, we observe that once a land block has been promoted (PROMO) to this category (from the previous year), it shows a positive and significant effect on its compensation (on its quality result). For quality B contracts, being promoted to this category does not have a significant influence on final output. However, the fact that the land block was demoted (DEMO), meaning that the previous year it was engaged in a higher quality contract, plays a positive and significant effect for C contracts. This could be interpreted as the fact that growers will exercise greater effort in order to be again promoted, or to "return", to the higher quality they once were.

[Insert table 3]

The monitoring variable, DOWN, has a negative and significant effect for all three contract. This means that the more the cooperative was able to identify and downgrade land blocks that are not complying with the contracts' specifications, (step 4, figure 1). Having chosen an A contract, and then being downgraded at this stage will translate in loss of proximally 2 644 euros for the grower. This variable does not include the downgrading of land blocks affected by a climatic or a disease incident; such effects are captured by the variable EFFCD, which has a logical negative effect on the final output. A similar effect is found in models 9-11 and 12-13, that is in the choice of contracts B and C.

As presented in section 3.1, the ceiling, in terms of yield, imposed on the cooperative's specifications (an additional contractual provision) is both an incentive for maximum effort and a penalty. The quality of grapes is related to a controlled (and fixed) ceiling of yield. But, because the price paid being a function of yield, we have a positive and significant effect for the variable YIELD. However, this relationship becomes negative (variable YIELD2) once a certain ceiling is breached.

The results of Models 8 through 13 indicate that the yield rule has the same result, regardless of the type of contract engaged in. We show this relationship between qualitative output and yield in figure 3. We notice a slight difference between high-quality A contracts and the rest. High quality A contracts are associated with low yields and high compensation. However, for quality B and C contracts, the penalties for exceeding the yield ceilings are less dramatic than that of A contracts. The behavior, at least in terms of respecting yield, is similar whether the initial contract is a B or a C.

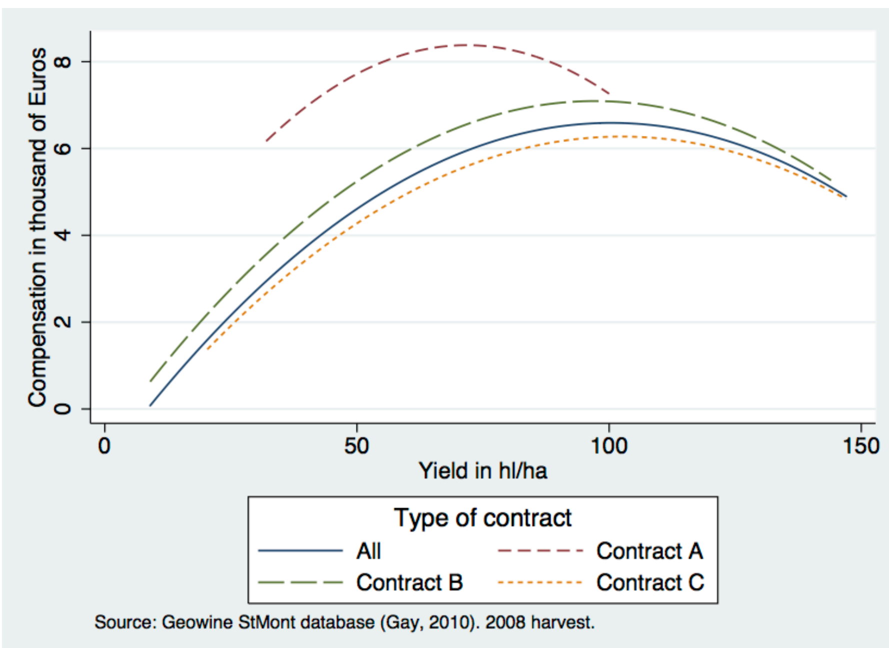

Figure 3: *Land block's compensation by yield.*

With regards to the growers' characteristics, age seems to have a role in quality output. Growers with more that 45 years old produce higher qualitative output for contract B that other growers. However, the experience of the grower in high-quality "A" contracts (NYA) plays a positive role on the qualitative output for contracts C (model 13). This result could mean that the more experience a grower has in stricter high-quality contracts, the more likely he is to do better in terms of quality effort. Overall, this result could mean that once a grower is used to the exigencies of high-quality specifications, it is more likely that he/she will apply those "good practices" to all their contracts. It seems that being specialized in viticulture (VINEYARD) has a negative influence the qualitative output of grapes, for those growers having choose B contracts. There is also, a slight positive effect for growers engaged in A contracts that belong to the "Cave d'Aignan" winery.

As for the characteristics of the land block, the main grape variety (TANNAT) plays positive role in compensation for contracts A through C. In fact, tannat is the main variety of the Saint Mont AOP and is the one preferred for the production of high quality wines. Quality is thus highly associated with grape variety.

Finally, with regards to the land block's pedoclimatic environment, we tested the influence of type of soil in which the land block is located, on final qualitative output. We found that high-quality contracts (Model 11) carried on Molasse soils are likely to increase by 390 euros the compensation of such contract, all things being equal. Without any expertise in agronomy or viticulture, we are not able to explain the relationship of this type of soil and the final qualitative output of grapes. However, if we infer that a positive relationship exists between this type of soil and the qualitative output of A contracts, it would have some management implications for the cooperative. First, it would mean that some types of soils are better fitted for carrying certain modes of cultivation (quality contracts) than others. This can be used by the cooperative to replant their vines or to reallocate the contracts proposed to growers to improve the overall quality of grapes. Second, it could also raise doubts about their incentive tournament system. In fact, growers owning land blocks within "rich" soils could have an advantage, regardless of their effort, compare to their peers and thus provide limited effort.

6 Conclusion

In this paper, we have focused on the relationship between a wine cooperative and its member-growers and the incentives mechanisms implemented to produce quality grapes. The cooperative's traceability database provides information to decision makers to better manage the production of quality grapes, which we used to test our hypotheses on the data from the 2008 harvest. More precisely, we show how a wine cooperative in the south west of France uses a differentiated payment system and contractual provisions, where promotion (or demotion) to (from) higher quality contracts works as an incentive for efforts to improve quality. This incentive system is similar to that of a tournament. In addition, the wine cooperative screens the growers by offering a menu of contracts and by monitoring their activities. The first screening mechanism takes place when the grower chooses the contract. The access to high quality contracts is explained by the cumulated experience on higher quality contracts and previous promotions, but also by the fact that land blocks belongs to a property or the grow of a specific grape variety: Tannat. Age of growers appears as a detriment to access high quality contracts, as youngster start with lower quality contracts.

Testing the tournament system itself, we found that promotion and demotion from quality engagement in previous years are significantly influences of quality performance. Once someone have been demoted from the previous year, he/she will exercise greater effort in order to be again promoted, or to "return", to the higher quality they once were. Monitoring plays a big role in the tournament system, as the decision whether to downgrade a land block of wine grapes to a lower quality when the minimum quality may not be achieved, can reduce the tournament mechanism efficiency. Finally, yield control act for all three types of contracts as both an incentive for maximum effort and a penalty.

Our results confirm that the tournament mechanism built by the cooperative aims at achieving two objectives: (i) providing incentives in presence of common shock that may affect all the growers; (ii) reducing the heterogeneity among the growers embedded in the same contest in order to increase the incentives provided by the tournament compensation scheme. This paper contributes to the tournament and contract literature in viticulture by showing that relative performance compensation systems, with the possibility of being promoted to higher quality contracts, is an incentive for growers to provide higher effort levels.

Acknowledgments

This research was funded by the French Government Fund for Research (FUI) and the Midi Pyrénées Region in the Geowine project (www.geowine.net). We are grateful to Michel Gay (EI Purpan), Olivier Bourdet-Pees and Laurent Seris (Plaimont Producteurs) for making the data available to us. We also thank Jason Franken and the participants at the sixth Annual Meeting of the American Association of Wine Economists in Princeton for their helpful comments. The analysis and comments made here are however our sole responsibility.

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Table 1 : Summary statistics and description of variables

Variable	Definition	Mean	Std. Dev.	Min	Max	N
REMTOT	Compensation of individual land block (thousand of Euros/ha)	4.758	1.609	0.114	9.141	1219
PROMO	Dummy variable, = 1 if land block have been promoted from 2007-2008	0.020	0.139	0	1	1219
DEMO	Dummy variable, = 1 if land block have been demoted from 2007-2008	0.015	0.121	0	1	1219
PROMO07	Dummy variable, = 1 if land block have been promoted from 2006-2007	0.019	0.136	0	1	1219
DEMO07	Dummy variable, = 1 if land block have been demoted from 2006-2007	0.011	0.103	0	1	1219
DOWN	Dummy variable, = 1 if downgraded from its quality category during year *t*	0.154	0.361	0	1	1219
Contract A	Dummy variable, = 1 if initial engagement in contract A	0.046	0.209	0	1	1219
Contract B	Dummy variable, = 1 if initial engagement in contract B	0.175	0.380	0	1	1219
Contract C	Dummy variable, = 1 if initial engagement in contract C	0.779	0.415	0	1	1219
YIELD	Average yield of land block (in hectoliters/ha)	54.472	14.390	9	147	1219
YIELD2	YIELD^2	3174.056	1752.526	81	21609	1219
EFFCD	Dummy variable, = 1 if a climatic or disease incident	0.060	0.237	0	1	1219
AGE_21-35	Dummy variable, = 1 if grower's age (21 to 35 years old)	0.068	0.252	0	1	1219
AGE_36-45	Dummy variable, = 1 if grower's age (36 to 45 years old)	0.331	0.471	0	1	1219
AGE_46-55	Dummy variable, = 1 if grower's age (46 to 35 years old) (in reference)	0.355	0.479	0	1	1219
AGE_>56	Dummy variable, = 1 if grower's age (more than 56 years old)	0.246	0.431	0	1	1219
GEND_F	Dummy variable, Grower's gender (= 1 if women)	0.171	0.376	0	1	1219
AGE_>45*F	Dummy variable, = 1 if woman over 45 years of age	0.125	0.331	0	1	1219
NYA	Number of year in contract A	2.564	2.147	0	5	1219
VINEYARD	Grower's viticulture surface/total arable land	0.237	0.164	0.013	0.736	1219
WINERY_1	Dummy variable, = 1 if grower belongs to Cave of Plaisance	0.192	0.394	0	1	1219
WINERY_2	Dummy variable, = 1 if grower belongs to Cave of Aignan	0.291	0.455	0	1	1219
WINERY_3	Dummy variable, = 1 if grower belongs to Cave of St. Mont (in reference)	0.517	0.500	0	1	1219
PROPERTY	Dummy variable, = 1 if land block is located within a domaine	0.109	0.312	0	1	1219
SURF	Logarithm of a contract's total surface in ha	0.425	0.206	0.022	1.407	1219
TANNAT	Dummy variable of grape variety (=1 if Tannat)	0.577	0.494	0	1	1219
Soil						
Gravel	(Presence of) Gravel Ancient Alluvium	0.072	0.259	0	1	1219
Clay	(Presence of) clay (or *Argiles bigarrées* in French)	0.179	0.383	0	1	1219
Molasse	(Presence of) Molasse	0.244	0.429	0	1	1219
Out of the zone	Out of the zone (in reference)	0.276	0.447	0	1	1219
Sand	(Presence of) iron-rich sand (or *Sables fauves* in French)	0.230	0.421	0	1	1219

Source: Geowine StMont database (Gay, 2010), 2008 harvest.

Table 2: Determinants of contract choice and compensation

	Probit results (M.E.) Dependent variable: type of contract						OLS results Dependent variable: REMTOT (land plot compensation)							
	Contract A = 1		Contract B = 1		Contract C = 1		if all contracts		if contract A		if contract B		if contract C	
	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
PROMO							0.073	(0.194)	0.462	(0.244)	-0.048	(0.210)		
DEMO											0.447	(0.695)	0.895***	(0.231)
PROMO07	0.152*	(0.067)	0.461***	(0.106)	-0.698***	(0.075)								
DEMO07	0.021	(0.049)	-0.088	(0.074)	0.061	(0.082)								
DOWN							-0.706***	(0.075)	-2.631***	(0.372)	-1.319***	(0.124)	-0.313***	(0.081)
Contract A							2.919***	(0.163)						
Contract B							1.009***	(0.059)						
YIELD							0.125***	(0.006)	0.245***	(0.049)	0.131***	(0.009)	0.119***	(0.007)
YIELD2							-0.001***	(0.000)	-0.002***	(0.000)	-0.001***	(0.000)	-0.001***	(0.000)
EFFCD							-2.947***	(0.117)	-6.677***	(0.405)	-3.888***	(0.183)	-2.502***	(0.107)
AGE_21–35	-0.005	(0.026)	-0.082*	(0.034)	0.094*	(0.037)	-0.014	(0.079)	0.171	(0.263)	-0.175	(0.238)	-0.018	(0.077)
AGE_36–45	0.006	(0.016)	0.037	(0.029)	-0.032	(0.030)	0.002	(0.061)	0.046	(0.223)	-0.064	(0.118)	0.024	(0.066)
AGE_>56	-0.003	(0.015)	0.007	(0.028)	0.002	(0.029)	0.013	(0.060)	0.115	(0.221)	0.248*	(0.116)	-0.033	(0.063)
GEND_F	0.010	(0.028)	-0.025	(0.051)	0.010	(0.054)	-0.193	(0.112)	-0.367	(0.317)	-0.200	(0.205)	-0.119	(0.106)
AGE_>45*F	-0.005	(0.030)	0.029	(0.069)	-0.018	(0.069)	0.141	(0.137)	0.166	(0.371)	-0.047	(0.284)	0.147	(0.136)
NYA	0.016***	(0.004)	0.012*	(0.005)	-0.025***	(0.005)	0.038***	(0.011)	0.017	(0.056)	0.018	(0.025)	0.039***	(0.012)
WINERY_1	0.004	(0.017)	-0.060*	(0.026)	0.059*	(0.029)	0.007	(0.063)	0.102	(0.164)	-0.015	(0.144)	-0.048	(0.068)
WINERY_2	-0.009	(0.013)	-0.057*	(0.024)	0.064*	(0.026)	0.102	(0.057)	0.311	(0.183)	0.167	(0.119)	0.013	(0.061)
TANNAT	0.071***	(0.010)	0.137***	(0.021)	-0.203***	(0.021)	0.371***	(0.050)	1.633***	(0.450)	0.416**	(0.139)	0.262***	(0.051)
VINEYARD	-0.025	(0.050)	0.066	(0.071)	-0.021	(0.079)	-0.164	(0.146)	-0.519	(0.475)	-0.778*	(0.316)	-0.033	(0.149)
SURF	-0.021	(0.029)	0.117*	(0.050)	-0.093	(0.054)	-0.030	(0.120)	-0.362	(0.311)	0.135	(0.253)	-0.074	(0.133)
PROPERTY	0.110**	(0.037)	0.004	(0.038)	-0.106*	(0.046)								
Gravel	0.014	(0.027)	0.022	(0.048)	-0.032	(0.050)	-0.066	(0.099)	0.361	(0.270)	-0.321	(0.210)	-0.009	(0.098)
Clay	-0.000	(0.017)	0.060	(0.038)	-0.060	(0.038)	0.086	(0.072)	0.161	(0.190)	-0.130	(0.157)	0.091	(0.078)
Molasse	-0.003	(0.016)	0.048	(0.032)	-0.041	(0.033)	0.064	(0.061)	0.327	(0.218)	-0.014	(0.119)	0.092	(0.065)
Sand	-0.003	(0.016)	0.056	(0.034)	-0.049	(0.034)	0.021	(0.068)	0.212	(0.212)	-0.089	(0.126)	0.090	(0.073)
Constant							-0.419*	(0.210)	-0.939	(1.390)	0.714	(0.370)	-0.375	(0.227)
Observations	1219		1219		1219		1219		56		213		950	
R^2							0.778		0.956		0.872		0.720	
Adjusted R^2							0.774		0.930		0.858		0.714	
Pseudo R^2	0.234		0.102		0.165									
BIC	475.93		1142.23		1202.91		2948.40		124.07		508.47		2184.04	

Robust standard errors in parentheses. M.E.: Marginal effects.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Efficiency of compensation system with sample selection

	Heckman results Twostep method Dependent variable: REMTOT (land plot compensation)						Heckman results ML method Dependent variable: REMTOT (land plot compensation)					
1st step contract choice:	Contract A		Contract B		Contract C		Contract A		Contract B		Contract C	
	(8)		(9)		(10)		(11)		(12)		(13)	
PROMO	0.457*	(0.186)	-0.026	(0.202)			0.458*	(0.189)	-0.025	(0.159)		
DEMO			0.458	(0.662)	0.872***	(0.213)			0.457	(0.318)	0.792***	(0.191)
DOWN	-2.645***	(0.303)	-1.314***	(0.118)	-0.315***	(0.080)	-2.644***	(0.191)	-1.313***	(0.112)	-0.315***	(0.069)
YIELD	0.245***	(0.040)	0.131***	(0.008)	0.119***	(0.007)	0.246***	(0.031)	0.131***	(0.009)	0.119***	(0.008)
YIELD2	-0.002***	(0.000)	-0.001***	(0.000)	-0.001***	(0.000)	-0.002***	(0.000)	-0.001***	(0.000)	-0.001***	(0.000)
EFFCD	-6.700***	(0.334)	-3.888***	(0.175)	-2.499***	(0.106)	-6.700***	(0.326)	-3.890***	(0.174)	-2.480***	(0.103)
AGE_21-35	0.200	(0.200)	-0.143	(0.226)	0.011	(0.078)	0.199	(0.297)	-0.140	(0.247)	0.084	(0.116)
AGE_36-45	0.041	(0.180)	-0.084	(0.117)	0.008	(0.065)	0.040	(0.163)	-0.087	(0.115)	-0.033	(0.072)
AGE_>56	0.130	(0.170)	0.248*	(0.110)	-0.039	(0.063)	0.129	(0.146)	0.248*	(0.121)	-0.056	(0.072)
GEND_F	-0.375	(0.250)	-0.177	(0.200)	-0.128	(0.108)	-0.375	(0.207)	-0.175	(0.215)	-0.158	(0.138)
AGE_>45*F	0.149	(0.300)	-0.072	(0.275)	0.156	(0.138)	0.150	(0.283)	-0.074	(0.266)	0.185	(0.165)
NYA	0.001	(0.046)	0.013	(0.024)	0.031**	(0.012)	0.002	(0.052)	0.013	(0.025)	0.010	(0.017)
VINEYARD	-0.518	(0.368)	-0.784**	(0.303)	-0.061	(0.150)	-0.518	(0.389)	-0.786*	(0.321)	-0.129	(0.183)
SURF	-0.358	(0.238)	0.099	(0.235)	-0.115	(0.135)	-0.358	(0.267)	0.094	(0.241)	-0.221	(0.150)
WINERY_1	0.095	(0.137)	-0.015	(0.137)	-0.033	(0.069)	0.095	(0.189)	-0.015	(0.147)	0.011	(0.079)
WINERY_2	0.297*	(0.141)	0.185	(0.115)	0.031	(0.061)	0.297*	(0.149)	0.187	(0.124)	0.082	(0.072)
TANNAT	1.603***	(0.360)	0.353*	(0.140)	0.197***	(0.053)	1.604***	(0.251)	0.347*	(0.142)	0.024	(0.095)
Gravel	0.353	(0.213)	-0.337	(0.202)	-0.017	(0.099)	0.354	(0.234)	-0.339	(0.193)	-0.040	(0.117)
Clay	0.139	(0.170)	-0.164	(0.158)	0.078	(0.077)	0.140	(0.215)	-0.168	(0.155)	0.040	(0.087)
Molasse	0.337*	(0.165)	-0.041	(0.120)	0.081	(0.066)	0.336	(0.176)	-0.043	(0.142)	0.047	(0.075)
Sand	0.186	(0.175)	-0.118	(0.123)	0.073	(0.072)	0.187	(0.169)	-0.122	(0.139)	0.028	(0.082)
Constant	-0.711	(1.404)	1.030*	(0.457)	-0.361	(0.226)	-0.721	(0.997)	1.065*	(0.537)	-0.332	(0.257)
rho							-0.244	(0.529)	-0.239	(0.242)	0.319**	(0.109)
mills	-0.082	(0.159)	-0.160	(0.182)	0.803**	(0.252)						
N	1219		1219		1219		1219		1219		1219	
Censored obs	1163		1006		269		1163		1006		269	
Uncensored obs	56		213		950		56		213		950	

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$